

The Ordovician–Silurian boundary in the Sierra de Villicum, Argentine Precordillera

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Synopsis

The Ordovician–Silurian boundary is defined within the Don Braulio Formation at its type locality near San Juan, Argentina. The boundary sequence consists of: 1, Upper Ashgill (Hirnantian) defined by the presence of *Hirnantia* cf. *sagittifera* and *Dalmanitina sudamericana*; 2, a short stratigraphical interval of 10 m of shales with unidentifiable graptolite fragments, perhaps Lower Silurian in age; 3, levels with acritarchs, chitinozoan and graptolites which can be related with certainty to the Lower Llandovery.

The stratigraphical section which includes the Ordovician–Silurian boundary in the Sierra de Villicum is perhaps the best known and palaeontologically controlled locality in South America. The Sierra (Range) of Villicum is situated in the Argentine Precordillera, in San Juan Province about 1100 km northwest of Buenos Aires (see Fig. 1). Upper Ordovician and Silurian sediments outcrop in the eastern flank of the range, and the best section is found in Don Braulio Creek, 35 km north of the city of San Juan. The section is well exposed, in a desert climate area, and the following formations are present:

Mogotes Negros Fm	Lower to Upper Silurian age
Don Braulio Fm	Ashgill to Llandovery age
La Cantera Fm	Llandeilo to Caradoc age
Los Azules Fm	Llanvirn to Llandeilo age
San Juan Fm	Arenig age
La Flecha Fm	Upper Cambrian to Tremadoc age
La Laja Fm	Lower to Middle Cambrian age

The first Ashgill macrofossils from South America were found in the Don Braulio Formation (Baldis *et al.* 1982). The brachiopods were described by Levy & Nullo (1974) and trilobites of the *Dalmanitina* faunal group by Baldis & Blasco (1975). Benedetto (1985) has reported the presence of *Hirnantia* associated with *Modiolopsis* (Sanchez 1985), which gives an accurate Upper Ashgill age for the top of the lower Don Braulio Formation.

The trilobites found in the lower part of the formation are *Dalmanitina* (*D.*) *sudamericana* Baldis & Blasco and *Calymenella* (*Eohomalonotus*) *villicunensis* Baldis & Blasco, and brachiopods belonging to the genera *Fascifera*, *Arenorthis*, *Bagnorthis* and *Kjaerina* (*Neokjaerina*). From the middle to the upper part of the lower portion of the formation are reported *Hirnantia sagittifera* (M'Coy) and *Dalmanella* aff. *D. testudinaria*, associated with *Modiolopsis*, *Nuculopsis* and *Palaeoneilo*. The lower part of the formation is separated by several metres of shales with indeterminate remains of graptolites from the upper part.

In the base of the upper part of the formation, Volkheimer *et al.* (1980) determined a chitinozoan microflora composed of *Ancyrochitina* cf. *ancyrea* (Eisenack) Eisenack, *Conochitina* cf. *chydae* Jenkins, *Desmochitina* (?) sp., *Cythochitina* cf. *campanulaeformis* (Eisenack) Eisenack, *Euconochitina filifera* (Eisenack) Tang, *Rhabdochitina* sp. A, and *Spathachitina* cf. *clarindoi* da Costa. The Llandovery age of the association is indicated by the presence of Ordovician–Lower Silurian chitinozoa together with Lower Silurian ones. The genus *Spathachitina* da Costa indicates a Lower Silurian age in the Amazon Basin of Brazil. Pöthe de Baldis (1980) described a varied microflora of acritarchs from the same level, with 26 genera and 47 species, of which 34 are known from other countries, mainly northern Spain, Belgium, England and northern Africa. The association shows a predominance of *Veryhachium trispinosum*, followed in importance by *Eupoikilofusa tenuistriata* (Pöthe de Baldis) *aperturata* n. var. The genus *Eisenackidium*

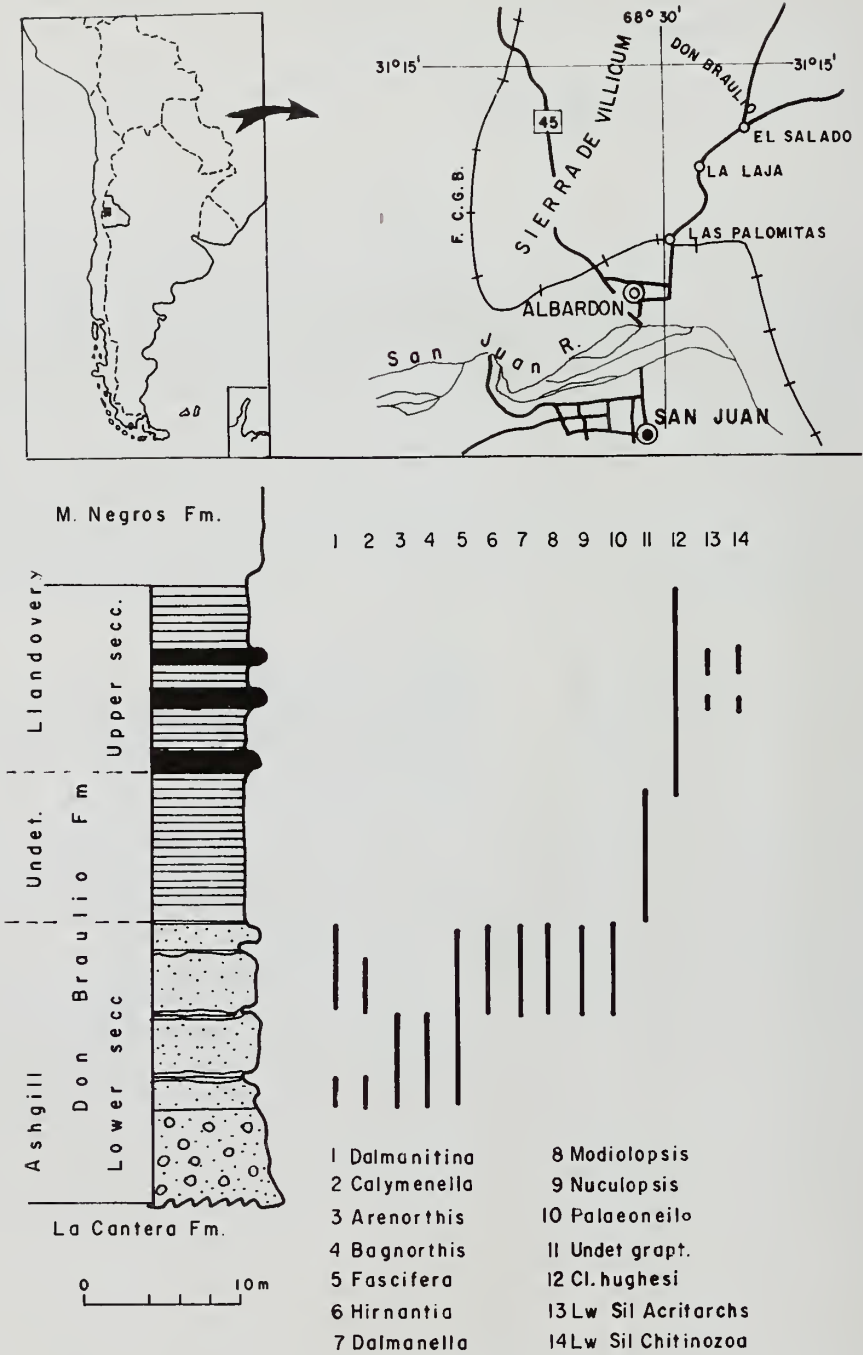


Fig. 1 The location of the type locality of the Don Braulio Formation (above), and a section through the formation showing the distribution of the fossils mentioned in the text (below).

was recorded for the first time from the Lower Silurian (formerly only described from the Lower Devonian). Other forms such as *Veryhachium tetraedron* Deunff, *Marrocanium simplex* Cramer *et al.*, *Multisphaeridium alloiteaui* Deunff and *M. cf. remotum* (Deunff) are typical of Ordovician sediments. The age of the association is based on the presence of *Tunisphaeridium tentaculaferum* (Martin) and *Domasia limaciforme* (Stockman & Willièrre) whose first appearance is in the Lower Llandovery of England and Belgium.

The graptolites appearing in all parts of the Upper Section of the Don Braulio Formation were determined by Peralta (in press) as the typical Lower Silurian assemblage of *Climacograptus* aff. *C. hughesi* (Nicholson), *Monograptus* sp., *Glyptograptus* sp. and *Rastrites* sp.

The Don Braulio Formation has 40 m thickness in the type locality. A brief description of the section is as follows (also see Fig. 1):

A. Hematitic Member:

9 Pale green-greyish shales (strongly deformed), with spots of iron oxides and scattered ramous graptolites	2 m
8 Oolitic sandstones weathering dark red; red brownish to green in fresh fracture. Acritarchs and chitinozoa occur	0.50 m
7 Pale green-greyish shales, intercalated with thin hard siltstones and fine-grained sandstones of 2 cm thickness	2 m
6 Oolitic sandstone similar to Bed 8 but with fewer oolites, with indeterminable monograptid stipes.....	1 m
5 Green-greyish hard siltstone with some shaley levels and <i>Climacograptus hughesi</i>	3 m
4 Hematitic siltstones (poorly bedded)	1 m

B. Silty and Shaly Member:

3 Dark green shales and siltstones (highly deformed) alternating with pale green-greyish clay, with fragments of unidentifiable graptolites (Monograptidae?)	10 m
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C. Conglomerate and Sandstone Member (Lower Section):

2 Dark green to green-greyish fine-grained sandstones (poorly bedded) with the trilobites <i>Caly-menella (Eohomalonatus) villicumensis</i> , <i>Dalmanitina sudamericana</i> and the brachiopods <i>Fascifera punctata</i> , <i>Hirnantia cf. sagittifera</i> , <i>Dalmanella cf. testudinaria</i>	12 m
1 Basal oligomictic conglomerate with intercalations of green-greyish lenses	6 m

Unconformity ~ ~ ~ ~ ~

La Cantera Formation (Llanvirn to Caradoc).

From the above we may conclude that the Ashgill is well dated in the whole sequence with trilobites, brachiopods and *Hirnantia cf. sagittifera* at its top. Ten metres of barren shales follows this section, followed by a Llandovery graptolite fauna and acritarchs and chitinozoans of Lower to Middle Llandovery age.

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